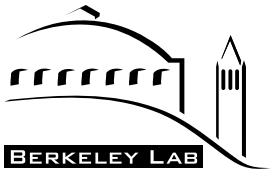

Radiation Protection Program for the Lawrence Berkeley National Laboratory

Revision 6

May 3, 2002

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Environment, Health and Safety Division
Radiation Protection Program

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LAWRENCE BERKELEY NATIONAL LABORATORY RADIATION PROTECTION PROGRAM

Contents

1. INTRODUCTION

This Radiation Protection Program (RPP) is being submitted pursuant to 10 CFR 835. This LBNL RPP Rev. 6 updates LBNL RPP Rev 5.. An attached implementation Matrix shows implementation commitment and status for each section of the Rule. RPP changes resulting from the amended rule are also flagged in the matrix. For ease of review, the matrix shows the changes from the previous version of the Rule.

Implementation schedule: All sections of the RPP are implemented with the exception of DOEP Bioassay accreditation (explained in the matrix).

This document describes, in general terms, the radiological use and ionizing radiation protection activities at Lawrence Berkeley National Laboratory. When the term "radiation" is used in this RPP, it refers to ionizing radiation. . It documents the radiation protection organizational structure and outlines the major program components that implement applicable regulations and requirements. The scope of the program includes the general provisions and exclusions listed in 10 CFR 835.1, yet incorporates program elements that go beyond those covered by 10 CFR 835, such as the radiological environmental protection program, the radioactive waste disposal program, and protection of human subjects. The aim of this document is to include all information that would be required for an external (NRC or Agreement State) Materials License Application. RPP Rev. 4, was reviewed by NRC as a mock license application during the NRC Pilot that took place at LBNL in 1998. Supplemented by answers to NRC follow-up questions, NRC concluded that the radiation protection program was documented in sufficient detail for an NRC Broadscope Materials License to be issued. To better position itself for possible transition to external regulation, LBNL will continue to structure its RPP in this manner.

The RPP incorporates standards that were selected by LBNL and the Department of Energy during the Work Smart Standards Process. In assessing the full range of radiological hazards and issues at LBNL, a number of standards were deemed appropriate to implement or supplement the federal radiation protection regulations. Examples are ANSI standards for accelerators and x-ray generating machines, International Air Transport Association (IATA) and Department of Transportation (DOT) dangerous goods shipping regulations, and US Food and Drug Administration (FDA) regulations for radiation protection of human subjects.

No exemptions to 10 CFR 835 are being sought.

INTRODUCTION (Continued)

The RPP is designed as a first-tier program description.. This document serves a dual purpose. It contains the 10 CFR 835 RPP and additional requirements that are part of LBNL's broader RPP which meet solely contractual Work Smart Standard or mock NRC license requirements. Sections of this document that are included due to the latter requirements, but are not part of the 10 CFR 835 RPP are specified and marked within the document.

In accordance with 10 CFR 835.104, written internal procedures commensurate with radiological hazards at LBNL and consistent with the education, training, and skills of the individuals exposed to those hazards have been developed and implemented. Internal procedures, however, are not invoked as enforceable 10 CFR 835 requirements, except to the extent they state specific 10 CFR 835 or 10 CFR 835 RPP requirements. Portions of these procedures that do not state such specific requirements will be updated and revised without revising the RPP.

1.1 Definitions

The following terms used in this RPP are not defined in federal regulations. Definitions in 10 CFR 835 are adopted.

"Radiological Control Technician" (RCT) is defined as a radiological worker whose primary job assignment involves monitoring of workplace radiological conditions, specification of protective measures, and provision of assistance and guidance to other individuals in implementation of radiological controls.

"Radiation Protection Organization" (RPO) is the organization at LBNL that controls the use of radiation on site. It consists of health physicists, RCTs, and technical and administrative staff who perform radiological hazards analysis, monitoring, sample and dosimeter analysis, and other duties described in this RPP. This group is a supervised by the Radiological Control Manager (RCM), and is a sub-unit of the LBNL Environment Health and Safety Division.

2. FACILITY DESCRIPTION—SCOPE OF ACTIVITIES

2.1 Mission

LBNL is a multi-program national research facility operated by the University of California for DOE. As an element of DOE's National Laboratory System, its fundamental mission is to provide national scientific leadership and technological innovation to support the DOE's objectives in fundamental science, energy resources, and environmental quality. LBNL's mission addresses four distinct goals:

- To perform leading multidisciplinary research in the energy sciences, general sciences, and biosciences in a manner that ensures employee and public safety and protection of the environment.

- To develop and operate unique national experimental facilities that are available to qualified investigators: the Advanced Light Source, National Energy Research Scientific Computing Center, Energy Sciences Network (ESnet), National Center for Electron Microscopy, 88-Inch Cyclotron, Biomedical Isotope Facility, and National Tritium Labeling Facility.

- To educate and train future generations of scientists and engineers to promote national science and education goals.

- To transfer knowledge and technological innovations and to foster productive relationships among LBNL research programs, universities, and industry to promote national economic competitiveness.

The Laboratory mission supports DOE's mission to "provide Americans with a secure and reliable energy system that is environmentally and economically sustainable" and to "ensure that the United States sustains its leadership in science and technology," as enunciated in DOE's Strategic Plan.

2.2 Laboratory Operations

To support the national infrastructure for fundamental science and engineering research, LBNL provides a range of unique research facilities and centers for LBNL investigators and users from industry, universities, and government. The major facilities at LBNL that utilize or produce radiation include the following:

- The Advanced Light Source (Building 6) provides photon beams of unprecedented brightness and coherence and with picosecond time structure. The 50 MeV electron injector was commissioned in FY 1992, and the 1.5 GeV electron storage ring was commissioned in FY 1993. The facility began operation in the fall of 1993.

2.2 Laboratory Operations (continued)

- The 88-inch Cyclotron (Building 88) provides light ions, polarized protons (up to 55 MeV) and deuterons, and intense and high-charge-state beams of heavy ions (up to uranium) at energies up to 32 MeV per nucleon. The cyclotron facility has experimental areas for conducting nuclear science experiments, as well as research in other areas such as life sciences, atomic physics, and radiation damage in semiconductors.

- The Biomedical Isotope Facility (BIF) in Building 56 houses a commercially available, self-shielded mini-cyclotron that accelerates protons up to energies of 11 MeV. The cyclotron is used to create short-lived positron-emitting nuclides such as F-18, which are chemically incorporated into pharmaceuticals. The products are subsequently used for performing various Positron Emission Tomography (PET) scans and research. The accelerator targets, once irradiated, can have their contents transferred automatically, via tubing, to a glove box laboratory in the same building, where the radiopharmaceuticals are manufactured. Typical production is on the order of 1 Ci. Labeled compounds range to 0.1 Ci. Once the final product has been prepared, it will be transported to Building 55, the Radiation Medicine Building, for further use with patients or research. The product is transported to Building 55 either manually (in a shielded container) or via a pneumatic transfer system.

- Instrument calibration facilities use sealed sources containing up to 30 Ci of Cs-137 , 88 Ci of Pu-238, 5 Ci of Pu-239, and 1 Ci of Ra-226.

- A storage facility in Building 70, Room 147A houses radioisotopes in a highly secured, concrete-lined, fire-resistant room with a concrete shielded storage pit. The highest activity materials are stored in the storage pit in shielded containers. Stored radioisotopes, whose activity exceeds a small fraction of DOE STD-1027 Category 3 Nuclear Facility thresholds, are contained in 2R containers certified to be constructed to meet Department of Transportation requirements for the 2R inner package of a Type B container.

- A Hazardous Waste Handling Facility (HWHF), Building 85, includes the following radioactive waste functions:

  Compaction

  Solidification

  Neutralization

  Packing

  Total inventory of the HWHFis less than DOE STD 1027 Category 3 thresholds (exception: a threshold of 16,600 Ci is used for H-3, as approved by DOE in the safety analysis process). These thresholds vary from 16,600 Ci for H-3 to 0.5 Ci for actinides. The inventory of each radioisotope divided by its Category 3 threshold is summed. The sum must be less than 1.

- A shielded room irradiator in Building 74, with an approximately 1000 Ci. Co-60 source. Two other Co-60 sources totaling approximately 200 Ci. are also stored in shielding in the room.

Hazard analysis and operational safety requirements for each of the facilities above are documented in approved Safety Analysis Documents. For all uses of radiation, however, line management is responsible for obtaining authorizations under the guidelines in Section 7.

In addition to these facilities, other research facilities using radiation include approximately 200 laboratories using radioactive tracers at microcurie to low millicurie levels. Also, there are actinide chemistry laboratories that perform chemical reactions in glove boxes with up to millicurie amounts of actinide isotopes. There are several radiation-producing devices such as high voltage x-ray emitting test stands, high-energy electron microscopes, and various x-ray emitting analytic devices, such as diffraction units.

The medical research facility in Building 55 conducts projects involving human use of radioisotopes for clinical diagnostic purposes (Positron Emission Tomography and Single Photon Computed Tomography scanning).

There are three offsite buildings operated by LBNL that involve radioactive materials:

1. 2 buildings on the University of California, Berkeley campus, LBNL Building 1, Donner Laboratory and LBNL Building 3, Calvin Hall. Tracer quantities of labeled compounds (beta-gamma emitters such as H-3, S-35, P-32, I-125) are used in biological research. Personnel doses, emissions, and offsite doses are negligible, as documented by stack sampling and the Dosimetry Program.

2. A building (LBNL Building 903) at 2700 7th Street, Berkeley CA, a warehouse storage facility in an industrial area of Berkeley. The building houses shielding blocks and magnets with microcurie quantities of activated material, mainly Co-60. There are no personnel doses or emissions associated with this facility.

2.3 Nuclear Facilities

LBNL has no facilities that are classified as DOE Category 1,2, or 3 Nuclear Facilities under DOE STD 1027-92. All major facilities have DOE-approved accident analyses that demonstrate the lack of significant radiological consequences.

2.4 Limitations

LBNL does not operate any facility that possesses, handles, or stores critical mass quantities of fissile special nuclear material.

3. SAFETY PRINCIPLES, MANAGEMENT, AND ADMINISTRATION

3.1 Integrated Safety Management

LBNL commits itself to perform radiation work safely, in a manner that strives for the highest degree of protection for employees, participating guests, visitors, the public, and the environment, commensurate with the nature and scale of the work. To achieve this goal, the Lab has formed an Integrated Safety Management Plan. This Plan is based on the following principles, which are reflected in the detailed policies and procedures of the Laboratory. Principal investigators, managers, and supervisors are expected to incorporate these principles into the management of their work activities. While these principles apply to all work, the exact implementation of these principles is flexible and can be tailored to the complexity of the work and the severity of the hazards and environmental risks.

1. Line Management Responsibility for EH&S. Line management is responsible for the protection of the public, the workers, and the environment. More specifically, Laboratory line managers are responsible for integrating EH&S into work and for ensuring active, rigorous communication up and down the management line and with the workforce.

2. Clear Roles and Responsibilities. Clear and unambiguous lines of authority and responsibility for ensuring EH&S are established and maintained at all organizational levels within the Laboratory, and for work performed by its contractors. At the LBNL, this principle is manifested in contract language, position descriptions, personnel appraisal reviews, and work authorization documents.

3. Competence Commensurate with Responsibilities. Personnel possess the experience, knowledge, skills, and abilities that are necessary to discharge their responsibilities. LBNL management takes steps to ensure the appropriate depth and breadth of technical talent in EH&S is available and that the Laboratory has in place the means for periodically evaluating competencies. Competence includes training, experience, and fitness for duty.

4. Balanced Priorities. Resources are effectively allocated to address EH&S, programmatic, and operational considerations. Protecting the public, workers, and the environment is a priority whenever activities are planned and performed.

3.1 Integrated Safety Management (continued)

5. Identification of EH&S Standards and Requirements. Before work is performed, the associated hazards are evaluated and an agreed upon set of standards and requirements is established. These standards, if properly implemented, provide adequate assurance that the public, workers, and the environment are protected from adverse consequences. At the LBNL this is accomplished through periodic review of the agreed-upon set of standards developed using the Work Smart Standards protocol. Results of Self-Assessment roll-ups, planned EH&S Division reviews, and other independent or external reviews shall be considered during this review.

6. Hazard Controls Tailored to Work Being Performed. Administrative and engineering controls to prevent and mitigate hazards are tailored to the work and associated hazards.

7. Operations Authorization. The conditions and requirements to be satisfied prior to and during operations are clearly established and agreed upon. An example is the Radiological Work Authorization Program, which is discussed in Section 7.

The principles above are implemented through the following Core EH&S Functions, which are a part of every aspect of work at the Laboratory:

1. Work Planning. Clear definition of the tasks to be accomplished as part of any given activity.

2. Hazard and Risk Analysis. Analysis and determination of the hazards and risks associated with any activity, in particular risks to employees, the public, and the environment.

3. Establishment of Controls. Controls sufficient to reduce the risks associated with any activity to acceptable levels are established. Acceptable levels are determined by responsible line management, but are always in compliance with all applicable laws and Work Smart Standards.

4. Work Performance. Conduct of the tasks to accomplish the activity in accordance with the established controls.

5. Feedback and Improvement. Implementation of a continuous improvement cycle for the activity, including incorporation of employee suggestions, Lessons Learned, and employee and community outreach, as appropriate.

These Core EH&S Functions apply at all levels of the Laboratory—at the institutional level, the division or department level, and at the level of individual projects or work activities.

3.2 Institutional Functions

At the institutional level, the Core EH&S Functions are addressed through Laboratory-wide policies and procedures.

Core EH&S functions performed at the institutional level include an Integrated Hazard Assessment and the selection of Work Smart Standards, based on the hazards identified. The Work Smart Standards have been incorporated into the DOE contract with the University of California and are the basis of work controls instituted at LBNL. Decision making for institutional EH&S issues has been delegated to the EH&S Division Director, who makes decisions in consultation with Laboratory management.

The major institutional committee overseeing the RPP is the Radiation Safety Committee, which is described in detail below. The RCM in the EH&S Division has primary responsibility for RPP management. The functions of the RCM are also described below.

Responsibility for the implementation of this RPP rests with the LBNL Laboratory Director, as assigned by the University of California, which currently contracts with the Department of Energy to operate LBNL. To ensure development and maintenance of the RPP, the Director assigns a RCM who staffs and leads the Radiation Protection Organization(RPO). The RCM reports to the Director through the Director of the Environment Health and Safety Division and the Deputy Laboratory Director for Operations. The RCM has access to the Laboratory Director as necessary to assure effective implementation of the RPP. The Laboratory Director assigns a qualified Radiation Safety Committee that is responsible for advising LBNL Management on all matters related to occupational and environmental radiation safety and providing oversight of the Radiation Protection Program. The RPO provides support to the line functions necessary to discharge LBNL responsibility for compliance with the applicable regulations.

3.2.1 Radiation Safety Committee

The Radiation Safety Committee (RSC) is responsible for advising LBNL Management on all matters related to occupational and environmental radiation safety. The RSC reviews and recommends approval of occupational, public and environmental radiation safety policies, reviews radioactive waste issues and provides oversight of the Radiation Protection Program. The scope of its actions is in issues of broad institutional concern and impact, or areas of potential high consequence either in terms of safety or institutional needs.

The RSC also provides a forum to ensure that important radiation safety issues receive appropriate, balanced, and expert review before being acted upon by the Environment, Health, and Safety Division. The RSC reviews and approves institutional ALARA goals for occupational and public exposure to radiation, and provides oversight of the LBNL ALARA Program. Major authorizations for radiation use are reviewed and approved by the RSC. The RSC Charter is attached as Appendix A.

3.2.2 Radiological Control Manager (RCM)

The Radiological Control Manager (RCM) is responsible for development and implementation of the LBNL Radiation Protection Program. With the RSC, the RCM oversees the site wide ALARA Program. The RCM staffs and leads the RPO, provides technical management of all facets of the program, and ensures that the program is in compliance with applicable regulations. Maintenance and revision of the RPP documentation are also responsibilities of the RCM. The RCM reviews and approves all authorizations to use radiation in conjunction with the RSC, and brings other radiation protection issues to the RSC as appropriate.

The RCM provides routine reports to the RSC regarding the ALARA program and other RPP implementation items of concern.

3.3 Goals and Assessments

EH&S activities are assessed by several external and internal authorities. Examples of external authorities who currently assess components of the RPP are DOE Headquarters, the local DOE Field Office, the University of California Office of the President, the USEPA, and the East Bay Municipal Utility District. Recently, the Nuclear Regulatory Commission (NRC) conducted a site assessment to determine if LBNL could operate under external (NRC or Agreement State) regulation.

Internal mechanisms to assess the program include the Safety Review Committee triennial review, an institutional roll-up of division Self-Assessments, Office of Assessment and Assurance reviews, and integrated functional appraisals.

The contract with the University of California has performance goals associated with radiation protection. The current goals are based on occupational and public radiation exposures and reportable radiation occurrences. These goals are tracked quarterly, with a comprehensive evaluation performed annually, and submitted to the University of California. A performance-based rating is then assigned.

A full self-assessment of the RPP program content and implementation of 10 CFR 835 is undertaken at least every 36 months. The assessment includes evaluation of all functional areas of the RPP: organization and administration, ALARA program, external and internal dosimetry programs, area monitoring and control, area radiation monitoring, airborne radioactivity monitoring, contamination monitoring, and control, instrument calibration and maintenance, radiological control, radiological work planning, entry and exit controls, radiological work controls, posting and labeling, release of materials and equipment, sealed radioactive source, accountability and control, records, reports to individuals, and radiation safety training.

3.4 Division/Department Level Functions

Assessments carried out at the Division level include integrated functional appraisals and integrated hazards assessments, where hazards and risks are identified and reviewed against the Work Smart Standards. Division internal controls are established through Division Safety Coordinators and Division Safety Committees, who help perform self-assessments and coordinate compliance with the RPP and other EH&S programs. Each Division prepares, with the help of EH&S, reports of accidents and occurrences. Corrective actions resulting from occurrences, self assessments, and institutional assessments are prepared and tracked by divisions. Division Directors have the responsibility to assure that mechanisms are in place to assure that requirements are followed. Division Directors, as well as work leaders, are signatories on Radiological Work Authorizations.

3.5 Project- or Activity-Level Functions

Principal investigators, managers, and supervisors are required to consider the EH&S hazards, risks and concerns present, and to implement safety requirements. They are required to assure that the employee knows how to perform the work safely and in conformance with applicable EH&S requirements, and to provide on-the-job training as needed. The principal investigator, supervisor, or manager documents the work and associated hazards, describe administrative and engineering controls, and documents training or certification for the participants. These processes assure that experts with appropriate certifications or background are brought into the process for review or approval. Principal investigators, managers, and supervisors are responsible for assuring that all applicable EH&S requirements are implemented for all operations under their purview. All employees, visitors, and participating guests are expected to comply with these requirements in their work. Results of assessments and EH&S inspections must be followed up. In addition, a "Stop Work" procedure exists that requires the termination of any activity by a worker or supervisor if it poses an imminent danger. Within each Division, work or research leaders (described below) have the primary responsibility of carrying out radiological work under their purview in accordance with an authorization (Section 7). Individual workers must carry out radiological work in a manner that is safe and in compliance with regulations and authorization restrictions. Worker responsibilities in the RPP are also summarized below.

3.5.1 Work Leader

The Work Leader (WL), a principal research investigator or facility manager in charge of a project using radiation, provides detailed information to the RPO to assist in preparation and implementation of the authorization for radiation use. The authorization process is described in Section 7. In addition to the responsibilities of a radiological worker, the WL ensures that good work practices are followed by those under his/her supervision, and that authorization requirements/limits are strictly followed. The WL must notify the RPO prior to any changes in radioisotope use, and of any hazardous situations that arise. The WL will receive feedback regarding radiological safety performance from the RPO and is responsible for carrying out corrective actions. The WL must train authorized radiological workers on the job, as required.

3.5.2 Radiological Worker

A radiological worker must be properly trained in accordance with this RPP, and be aware of safe work practices and requirements in the authorization and general LBNL rules. Radiological workers must report unsafe conditions to their work supervisor. Radiation monitoring must be performed frequently during work to facilitate contamination and radiation source control and assure that work is done per ALARA principles.

3.6 Resources

3.6.1 Radiation Protection Organization

The core RPO at LBNL within the Environment, Health and Safety Division (EH&S) consists of health physicists, technologists, radiological control technicians (RCTs), and administrative support staff. The following programs have at least one health physics supervisor and one or more RCTs assigned.

- Radiological Work Authorizations
- Radiological Work Permits
- Radioactive Material Transportation
- Sealed Source Authorizations
- Radiation-Producing-Machine Program and Authorizations
- NMMSS Program

Other programs carried out by RPO are Radiation Protection Training, ALARA, Quality Assurance, and Regulatory Affairs.

Within the RPO, the a services organization has health physicists and technical specialists performing instrument calibration, dosimetry services, and radioactive material analyses.

Qualification by the American Board Health Physicists or National Registry of Radiation Protection Technologists is encouraged. Some of the RPO personnel have certification by these organizations.

One-time projects, such as facility decommissioning, are supervised by permanent staff but may also utilize contract employees. Contract employees must have the same qualifications as permanent employees.

The RCM supervises the health physicists leading these programs and may adjust reporting relationships as needed. The RCM reports to the Director of the EH&S Division.

Other professional and technical staff perform duties in the areas of radiological environmental protection (see Section 5.6) and radioactive waste disposal (see Section 15). These operations reside in other EH&S groups.

A current organizational charts showing the RPO and reporting structure to the Laboratory Director is in Appendix B. Reporting lines within the RPO and other groups may change, but the programs and functions described in this RPP shall remain in place.

3.6.2 Facilities

Radiation Dosimetry Laboratory. This laboratory provides dosimetry services for external (whole body and extremity), environmental, and area workplace monitoring (using passive or active detectors), and in-vivo analyses for internal dosimetry. The internal dosimetry program shall achieve DOELAP accreditation according to the schedule in the attached compliance matrix. The external dosimetry program is DOELAP-accredited and uses thermoluminescent dosimeters (TLDs) for beta, gamma, and neutron monitoring of individuals as well as workplace monitoring. In conjunction with the accredited TLDs, track-etch detectors are used for neutron evaluations. Extremity monitoring is provided in the form of finger rings. The measurement calibrations cover a wide range from environmental levels (0.1 millirem) to accident levels (500 rem). Examples of equipment include:

- TLD readers
- various types of whole body dosimeters (e.g. Harshaw 802, 810, 813 TLD, and CR-39 track etch)
- CR-39 wet chemistry laboratory
- in-vivo analyses through whole-body counting facility and thyroid scanning (sodium iodide–based detectors with multichannel analyzers)

Note: Equivalent equipment may be substituted.

Analytical Chemistry Laboratory. This laboratory provides analyses of all radioisotopes over a wide dynamic range from low-level environmental to work place analyses. It contains a wet radiochemistry lab and count room, including

- liquid scintillation counters
- gas-flow-proportional counters for analyses of alpha/beta in swipes, solids, air filters, and evaporated liquids.
- gamma spectrometers for gamma analyses of a great variety of samples
- alpha-detector vacuum chambers with surface-barrier detectors for analysis of alpha emitters in swipes, evaporated liquids, and purified samples

3.6.2 Facilities (continued)

Instrumentation /Calibration and Maintenance Laboratory. This laboratory repairs and calibrates most fixed and portable radiation survey meters used in industry today. Onsite calibration of other instrumentation, such as air sampling repair and maintenance, scales, gas sniffers, and flow meters, is also provided through this laboratory. The personnel are responsible for the two calibration facilities and the instrument maintenance and repair shop. The calibration facilities house NIST-traceable beta, gamma, and neutron sealed sources for the calibration of instrumentation and dosimeters. Examples of radiation instruments used, maintained, calibrated, and repaired on site include

- Geiger-Mueller detectors
- NaI crystal meters
- ion chambers
- data logging equipment
- gamma scintillation detectors
- neutron detectors (various types)
- alpha air proportional meters
- hand and foot counters
- portable H-3 air monitors
- stack-monitoring equipment

The following italicized section is included to document the full program. It is not a part of the 10 CFR 835 RPP.

Environmental Monitoring Facilities. Below is a brief description of the facilities used to monitor ambient air, stack effluent, and direct radiation from LBNL operations. A more detailed description of the program is in Section 5.6.

1. Effluent Monitoring: Samples of gaseous effluents from stacks and liquid effluent from sewers are analyzed by on-and offsite laboratories to determine if releases meet regulatory requirements and to calculate offsite doses. Real-time monitors (tritium, alpha/beta, positron) are in place in stacks where there is a higher potential for release.

2. Environmental Surveillance: Soil, ground and surface water, vegetation, ambient air and other media are sampled, and direct radiation measurements are made at onsite and offsite locations to determine radiological impacts from operations and further identify public exposure. Telemetered monitors are in place onsite and at site boundaries with central logging read-out.

3.6.2 Facilities (continued)

3. Pre- and Postoperational Monitoring: An environmental study is done prior to startup of new facilities to determine baseline values. Similar studies are performed (such as soil and tank sampling) during decommissioning of facilities.

4. Meteorological Monitoring: Meteorological data are collected to better characterize and calculate the impact from effluent releases.

Waste Disposal Facilities. See Sections 2.2 and 15.

Effluent Control Facilities

Fume hoods and glove boxes are required via the hazard evaluation and authorization process (section7) for work when appropriate. Effluent filtration needs are evaluated also during the authorization process and required as needed. Fume hoods and glove boxes are surveyed for proper air flow (approximately 100 linear feet per minute air velocity through openings) on an annual basis per ANSI AIHA Z9.5 1992.

4. EXPOSURE LIMITS/ CONTAMINATION CONTROL LIMITS

4.1 Personnel Dose Limits

Dose limits are provided in Table 4-1 and shall not be exceeded, except for planned special exposures and emergency exposures. These situations are not anticipated and are therefore not applicable at LBNL. The limits are for total effective dose equivalent (sum of effective dose equivalent from external exposures and committed effective dose equivalent from intakes). In recording and assessing compliance with the limits, excluded are background radiation, radiation doses received as a patient for the purposes of medical diagnosis or therapy, doses received in an emergency per Section 13, or radiation doses received from voluntary participation in medical research programs. Occupational doses resulting from other activities excluded in 10 CFR 835.1(b) (1) through (5), shall be considered when determining compliance with dose limits.

4.1.1 Employees

See Table 4-1. Planned Special Exposures exceeding these values will be initiated in only the most extraordinary circumstances and shall be handled according to regulatory requirements. Non-uniform exposure of the skin shall be handled according to regulatory requirements.

4.1.2 Embryo/Fetus Dose Limits (Pregnant Employee)

After a female radiological worker voluntarily notifies her LBNL supervisor in writing that she is pregnant, for the purposes of fetal/embryo dose protection, she is considered a declared pregnant worker. The declaration may be revoked at any time by the declared pregnant worker.

1. LBNL may provide the option of a mutually agreeable assignment of work tasks, without loss of pay or promotional opportunity, such that further occupational radiation exposure is unlikely. Upon request, an assessment of potential workplace exposure shall be made.

2. For a declared pregnant worker the following limits apply:

    a. The dose limit for the embryo/fetus from conception to birth (entire gestation period) is 500 millirem.

    b. Efforts should be made to avoid exceeding 50 millirem per month to the pregnant worker.

3. If the dose to the embryo/fetus is determined to have already exceeded 500 millirem when a worker notifies her employer of her pregnancy, the worker shall not be assigned to tasks where additional occupational radiation exposure is likely during the remainder of the gestation period.

4.1.3 Minors, Visitors, and Members of the Public

Minor employees and students, visitors*, and members of the public shall be limited to an annual radiation dose equivalent of 100 millirem from LBNL sources. Minor employees are also limited to 10 per cent of the limits for the lens of the eye and shallow dose equivalent.

* Visitors are non-employees, such as tour groups, not classified as radiological workers.

Table 4-1. Summary of Dose Limits

Limits in this table shall not be exceeded and shall be maintained as low as reasonably achievable.

Type Of Exposure	Annual Limit
Employee: Whole body (internal + external)	5 rem
Employee: Lens of eye	15 rem
Employee: Extremity (hands and arms below the elbow; feet and legs below the knees)	50 rem
Employee: Any organ or tissue (other than lens of eye) and skin	50 rem
Declared Pregnant Worker: Embryo/fetus	0.5 rem in nine months
Minor employees and students (under age 18) Whole body (internal + external)	0.1 rem
Visitors and public: Whole body (internal + external)	0.1 rem

4.2 Administrative Control Levels For Radiation Exposure

Challenging administrative control levels have been adopted at LBNL as part of the formal ALARA program.

1. A DOE Administrative Control Level for workers of 2 rem whole body exposure per year per person is established for all DOE activities. Approval by the Program Secretarial Official (PSO) or designee is required prior to allowing a person to exceed this level.

2. Annual LBNL Administrative Control Levels have been established and are presented in Table 4-2. These levels are more restrictive than the DOE Administrative Control Level, reflecting LBNL's ALARA program.

3. Approval authorities to exceed the multi-tiered Administrative Control Levels are given in Table 4-2. Approvals shall be documented.

Table 4-2. Administrative Control Levels

Maximum Dose Equivalent (Annual), millirem				
Whole Body	Skin and Extremity	Lens of Eye	Any other Organ	**Approval to Exceed This Level**
2,000				DOE—PSO
500	5000	1500	5000	Level 1, Line Manager, RCM
1000	10,000	3000	10,000	Level 2, DLD Operations, Line Manager, RCM

4.3 Contamination Control Levels

1. A surface is considered contaminated if either the removable or total radioactivity is detected above the levels in Table 4-3.

2. Unless an area can be decontaminated to below Table 4.3 levels for removable contamination promptly, then it shall be posted as a Contamination Area. Appropriate protective clothing and exit frisking are required for work in Contamination Areas. Release surveys are also required for removal of equipment from such areas. See Section 5.4.

3. Surfaces with both removable and total radioactivity below Table 4.3 control levels are not subject to controls, and may be released without restrictions. These values are in compliance with DOE Order 5400.5. As an ALARA measure, surfaces with any detectable contamination are decontaminated to as far below table levels as possible, prior to release.

4. Surfaces where the total surface contamination levels exceed Table 4.3 values but have removable contamination less than the limits shall be controlled as follows when located outside radiological areas:

   - Routine radiological surveys shall be performed to detect contamination that may become removable over time.
   - Unrestricted access cannot cause a dose to any person greater than 100 millirem in a year.
   - •. Markings are to include the standard radiation symbol, clearly visible from all directions.

Table 4-3. Summary of Contamination Control Levels

Nuclide (See Note 1)	Removable (dpm/100 cm^2) (See Notes 2 & 3)	Total (Fixed + Removable) (dpm/100 cm^2)
U-natural, U-235, U-238 and associated decay products	1,000 alpha	5,000 alpha
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-129, I-125	20	100
Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	200	1,000
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above. Includes mixed fission products containing Sr-90.	1,000 beta-gamma	5,000 beta-gamma
Tritium organic compounds, surfaces contaminated by HT, HTO, and metal tritide aerosols	10,000	n/a

Notes to Table 4-3:

1. The values in this table apply to radioactive contamination deposited on, but not incorporated into, the interior of the contaminated item. Where contamination by both alpha- and beta-gamma-emitting nuclides exists, the limits established for the alpha-and beta-gamma-emitting nuclides apply independently.

2. The amount of removable radioactive material per 100 cm^2 of surface area should be determined by swiping the area with dry filter or soft absorbent paper while applying moderate pressure and then assessing the amount of radioactive material on the swipe with an appropriate instrument of known efficiency. For objects with a surface area less than 100 cm^2, the entire surface should be swiped, and the activity per unit area should be based on the actual surface area. Except for transuranics, Ra-228, Ac-227, Th-228, Th-230, Pa-231, and alpha emitters, it is not necessary to use swiping techniques to measure removable contamination levels if direct scan surveys indicate that the total residual contamination levels are below the values for removable contamination.

3. The levels may be averaged over one square meter provided the maximum activity in any area of 100 cm^2 is less than three times the values in Table 4-3.

4.4 Airborne Radioactivity Control Levels

1. Personnel should not be exposed unnecessarily to airborne radioactivity. Use of engineering and administrative controls to reduce the potential for internal exposure should be evaluated before allowing personnel, with or without respiratory protection, to enter areas with airborne radioactivity.

2. Occupied areas with airborne concentrations of radioactivity that are greater than or likely greater than 1 derived air concentration (DAC) at any time or greater than 10 percent of DAC, averaged over a week, shall be posted as an Airborne Radioactivity Area.

Note: For purposes of control and posting of airborne radioactive material, DAC values from 10CFR835 Appendices A and C shall be used.

5. MONITORING AND SURVEYS

5.1 Individual Monitoring

Individual personnel monitoring shall be performed for all individuals likely to receive doses specified, as follows.

External dosimetry shall be provided to personnel who, under typical conditions, are likely to receive one or more of the following:

- An effective dose equivalent to the whole body of 0.1 rem or more in a year.
- A shallow dose equivalent to the skin or to any extremity of 5 rem or more in a year.
- A lens of the eye dose equivalent of 1.5 rem or more in a year.
- Declared pregnant workers who are likely to receive from external sources a dose equivalent to the embryo/fetus in excess of 50 millirem.
- Occupationally exposed minors and members of the public entering a Controlled Area likely to receive, in 1 year, from external sources, a dose in excess of 50 millirem.
- Individuals entering a high or very high radiation area.

Internal dosimetry shall be provided to radiological workers who, under typical conditions, are likely to receive one or more of the following:

- Radiological workers likely to receive 0.1 rem or more committed effective dose equivalent, and/or 5 rem or more committed dose equivalent to any organ or tissue, from all occupational radionuclide intakes in a year.
- Declared pregnant workers likely to receive an intake resulting in a dose equivalent to the embryo/fetus in excess of 50 millirem.
- Occupationally exposed Minors and members of the public who enter Controlled Areas and are likely to receive, in 1 year, an intake resulting in a committed effective dose equivalent in excess of 50 millirem.

Internal guidelines in place specify action levels for monitoring based on radiation use levels. These guidelines may change, as long as the requirements above are met. A calculation of potential uptake is performed using parameters similar to those used to determine the need for air sampling (see section 5.3). Routine bioassay is performed if potential uptake is above the action levels noted above. If air sampling and/or contamination results indicate that uptake is suspected, a special bioassay shall be performed.

Reporting Levels: Reporting levels for internal and external dosimetry results have been derived, based on limits of detection and widely accepted standards. For external dosimetry the reporting level is 15 millirem (DOELAP LLD studies). For internal dosimetry, the reporting level is 1 millirem (negligible dose per NCRP Report 116). Results lower than these respective values shall not be considered positive. For consistency, doses estimated from survey or area monitoring data shall not be considered positive unless they are above the most restrictive reporting value of 1 millirem.

5.1.1 Dose Reports to Individuals

Radiation exposure data for individuals monitored in accordance with Section 5.1 shall be reported to the individuals as follows:

- upon request from an individual terminating employment (as soon as the data are available but at least within 90 days)
- annually
- upon request at any time from the individual monitored
- prior to required reporting to DOE of personnel dose, such as an overexposure, or pursuant to an Occurrence Report.

Reports to individuals shall contain the dose information specified in 10 CFR 835.702. Reports shall be in writing and shall include the site name and employee identification.

5.2 Surface Contamination and Exposure Rate Monitoring

All work and storage areas covered by the RWA program containing unsealed radioactive material are surveyed routinely for radiation levels and contamination. The survey frequency is determined by the activity and nature of the radioactive material specified in the Authorization (see Section 7). The principles of ISM are employed in determining survey requirements: Factors considered are the nature and amount of radioactive material currently in use, the qualifications of the workers performing supplemental surveys, history of contamination, and engineered controls. The typical RPO survey frequency is monthly. Some higher-risk operations are surveyed weekly and very low-risk operations or storage areas may be surveyed quarterly (the minimum frequency for RPO RWA surveys). RPO surveys are supplemented by surveys performed by facility radiation workers.

Areas with higher-than-background radiation levels as a result of radiation-generating devices are surveyed weekly to annually, depending on radiation levels and variation. When conditions can change, such as in an accelerator cave, a radiation survey is generally required on entry. More information on surveys of radiation generating devices is given in the RPP sections specific to those devices.

All RPO surveys required to be performed in support of a radiation authorization are documented.

Neutron and gamma area monitoring is performed by dosimeters and/or alarmed monitors. Monitors are specified by the authorization documentation. These are currently in place in the major three accelerators currently operating at LBNL (88" Cyclotron, PET Cyclotron, and ALS). Alarmed detectors are also in place near all analytic x-ray devices.

Dosimeters measuring neutron or gamma radiation are placed throughout the site where higher-than-background levels might be encountered by general employees. They are exchanged quarterly.

5.3 Airborne Contamination Monitoring

Air sampling is performed whenever there is a likelihood of an individual receiving 40 or more DAC-hours in a year. This is done by performing a calculation of expected uptake based on use levels and controls, taking ALARA and historical data into account. The potential for internal uptake is calculated from isotope, chemical form, type of use, activity and containment per NRC NUREG 1400. Air sampling is performed when a potential dose of 10 millirem per year is calculated, and if respiratory protection has been required. Real-time alarmed air monitoring is performed at higher use levels, or where unexpected increases in airborne concentrations could cause an individual to receive 40 DAC-hours in a week, based on historical measurements, or for high-risk operations.

5.4 Release of Potentially Contaminated Materials and Equipment

A release survey is required for potentially contaminated materials or equipment to be transferred from the following areas:

1. Contamination and High Contamination Areas, or Airborne Radioactivity Areas
2. Radioactive Material Areas where the material is suspected to be contaminated
3. Controlled Areas where the material is suspected to be activated

Survey and sampling as appropriate, of such material and equipment are conducted with appropriate instrumentation. Release to uncontrolled areas is allowed only if:

1. Surface contamination does not exceed levels in removable or total levels in Table 4.3. ALARA is applied such that contamination is as far below the limits as is reasonably achievable.
2. Volume contamination is less than the minimum detectable activity of external detection with appropriate equipment and/or standard sample assay (sampling is performed if volume contamination is likely due to monitoring results or process knowledge). Naturally occurring radioactive material in normal concentrations in material may also be released without restriction. Higher, risk-based limits for release of volume-contaminated material may be adopted for certain materials in conjunction with regulatory approval (DOE guidance for implementation of DOE Order 5400.5 shall be followed).

Materials with contamination exceeding these values may be released to controlled areas or moved to other radiological areas only if the contamination is fixed (removable contamination is less than Table 4.3) or the items are contained and properly labeled. Routine monitoring shall be done to verify the status of the containment of surface contamination. Administrative procedures shall be used to maintain controls.

The following italicized sections are included to document the full program. They are not a part of the 10 CFR 835 RPP.

5.4.1 Release of short-lived radioactive material after decay

Radioactive material having a half-life of less than 90 days may be segregated by isotope and allowed to decay for at least 10 half-lives (one half-life is added for each factor of 2 over 1 millicurie activity). It shall *then be surveyed in a low background area with appropriate instrumentation, and sampled if appropriate. If the survey is background, labels* shall *be removed and it will be released as nonradioactive.*

5.4.2 Release to the sanitary sewer

Radioactive liquids will be released to the sanitary sewer if they meet the requirements of DOE Order 5400.5. Effluent released from the sewer outfall must also meet the requirements of 10 CFR 20.2003 (Disposal by release into the sanitary sewer) and local utility district standards for hazardous material sewer releases. Analysis shall *be performed to verify that activities and concentrations meet requirements. Records of releases* shall *be maintained.*

5.5 Instrument Calibration

Instruments and equipment used for radiation monitoring shall be periodically maintained and calibrated on an established frequency. Instruments used shall be appropriate for the radiation encountered and environmental conditions, and routinely tested for operability. Instrumentation in the program includes field radiation survey instrumentation, air sampling and monitoring devices, environmental monitoring devices, and analytic laboratory equipment. Typical frequency of calibration is annual. Calibration procedures and frequency for each type of instrument are specified in internal procedures.

The following italicized sections are included to document the full program. They are not a part of the 10 CFR 835 RPP.

5.6 Environmental Monitoring

The main activities of the environmental Monitoring Program are listed at the end of Section 3.6.2. The current drivers for the program are NESHAPS (10 CFR 61 Subpart H), local utility district sewer effluent standards, and portions of DOE Orders 5400.1 and 5400.5 selected through Work Smart Standards. ALARA goals for public exposure are set at 10 percent or less of regulatory limits (regulatory limits are 10 millirem per year from airborne effluents, 100 millirem per year from all pathways to maximally exposed person). LBNL produces an Environmental Monitoring Plan that details the monitoring program.

5.6.1 Stack Monitoring:

Per LBNL agreement with EPA, a monitoring program is in place, based on modeled public doses from stack emissions. Continuous sampling or monitoring is required for sources that are modeled to cause over 0.1 millirem per year to the maximally exposed member of the public. Total effluents from LBNL may not cause an exposure of over 10 millirem per year to the maximally exposed member of the public. Currently, emissions from the 88 inch Cyclotron (Bldg. 88), The NTLF (Bldg. 75), the PET Cyclotron (Bldg. 56), the actinide research labs in Buildings 70 and 70A, and the Hazardous Waste Handling Facility (Bldg. 85) are continuously sampled or monitored.

5.6.2 Sewer Monitoring

A sampling station is in place at each sewer outfall to confirm the documented sewer release values from laboratories (see Section 5.4.2).

5.6.3 Environmental Sampling

Ground and surface water, vegetation, and soil are sampled to follow concentrations of radionuclides that have deposited as a result of effluent. Air is sampled for tritium (silica gel samplers) and particulates (filters) at various offsite and onsite locations to verify calculated values based on stack monitoring.

5.6.4 Telemetry

Radiation detectors are set up on site in the vicinity of direct sources such as accelerators and at site boundary locations to directly measure ambient and public exposure to direct radiation from significant sources.

5.6.5 Risk Analysis

Exposure potential to onsite and offsite personnel is calculated for new and existing major sources of radiation via the Safety Analysis Documentation Program and the NESHAPS annual report.

5.6.6 Reporting

The LBNL annual Site Environmental Report documents all results of the Environmental Monitoring Program each year.

6. ALARA PROGRAM

6.1 ALARA Program Overview

There is a program in place at LBNL designed to assure that radiation exposures are maintained as low as is reasonably achievable (ALARA). Worker dose is kept ALARA through programs such as design review, personnel training; monitoring the workplace, environment and emissions: and controlling work activities via the authorization programs. The extent and formality of the ALARA Program is driven by potential worker dose. Oversight of the ALARA Program is provided by the Radiation Safety Committee (RSC) in conjunction with the RCM.

The elements of the ALARA Program include the following:

- Commitment of all levels of management and the workforce at LBNL to the ALARA Program,
- Training including ALARA concepts for of all personnel involved in radiological operations,
- Appropriate methods of maintaining occupational exposure at new processes or facilities ALARA are integrated into planning, design review, and procedures,
- Radiological work planning and controls that assure occupational dose is maintained ALARA,
- Comprehensive audits conducted periodically and reported to the highest management levels, and
- Documentation of ALARA activities maintained to demonstrate compliance.

The following sections describe implementation of the elements.

EH&S policies, programs, and procedures spell out specific management and employee responsibilities. However, the people who have the most important role in reducing exposure, waste, and environmental effluents are the workers who use radioactive materials and radiation-producing devices. For each job involving exposure to radiation or radioactive material, each worker is responsible for understanding the job requirements, the radiological control measures, and ALARA practices. Workers and their managers are responsible for being aware of and understanding the radiation hazards in the workplace.

The authorization program provides a mechanism to assess work and devise and implement controls designed to limit exposure. Workers and line management are responsible for following the precautions and limitations required in the authorizations. The RSC has an oversight role in that they review major authorizations, develop ALARA goals, assess progress toward those goals, and conduct independent ALARA reviews when deemed necessary.

6.2 ALARA Design Review Program

Each new facility or operation using radiation is subjected to reviews prior to any commitment of any radiation work. LBNL follows formal review processes that culminate in reports called Safety Analysis Document (SAD), Activity Hazard Document (AHD), Radiological Work Authorization (RWA), Sealed Source Authorization (SSA), or Radiological Work Permit (RWP). Design and control measures are specified in the authorization basis for each facility or work process (SAD, AHD, RWA, SSA, RWP). See Section 7 regarding authorizations.

ALARA design review is incorporated into planning for new facilities and major modifications to ensure that design features and administrative controls for new facilities are selected and evaluated to meet regulatory requirements and keep radiation exposures to workers, the public, and the environment as low as reasonably achievable. The primary methods used are design features such as containment, ventilation, exhaust controls, and shielding. Administrative controls are used as supplemental methods of decreasing radiation exposures. Where the use of design features is impractical, administrative controls and procedural requirements are used to maintain exposures ALARA. When appropriate, ALARA optimization methods for selecting design alternatives shall be used (only if collective exposure for a facility is expected to exceed 1 rem per year). The design objectives are to maintain exposure rates to personnel as far below 0.5 millirem per hour average and maximum individual occupational exposures to as far below 20 percent of the applicable annual dose limits as is reasonably achievable. Control measures must provide additional assurance that maximum exposures shall not exceed exposure limits and shall be ALARA. Monitoring shall verify the effectiveness of control measures.

6.3 ALARA Work Reviews

ALARA work/experiment reviews assess radiological impacts, determine optimum radiological controls, track the effectiveness of controls, and document lessons learned. ALARA work planning is commensurate with the relative risks associated with the activity. ALARA reviews are determined by assessments through the work authorization process. The review is conducted for all operations, practices, and procedures that involve the potential for high individual or collective dose equivalent. The ALARA review is documented via the Authorization Renewal documentation and/or Observation of Experiment Review.

6.4 Dosimetry Reviews

The RPO routinely reviews periodic dose reports from the Dosimetry Office. These reports indicate the doses for all individuals who received positive dosimetry readings. This review helps ensure that ALARA measures are being effective and allows any dose that appears not to be ALARA to be raised to the appropriate management personnel. Additionally, the Dosimetry Office notifies the RPO of any individual dosimetry (internal and external) results that exceed predetermined alert level thresholds as soon as the result is deemed reliable. A validation is performed by RPO to verify that the dose received reflects the level of radiological work performed. When necessary, recommendations are made regarding the reasons for exposure and methods of exposure reduction.

6.5 ALARA Reports

The RPO prepares periodic reports for the RSC summarizing ALARA information and work activities. These reports may include information such as:

- results of dose investigations,
- results of ALARA reviews,
- cumulative radiation exposure,
- reportable radiological occurrences, and
- information on the number of personnel exceeding predetermined dosimetry alert levels.

Information contained in these reports is provided to the RPO staff, the RCM the RSC, and other levels of Laboratory management, as appropriate.

7. AUTHORIZATION BASIS

7.1 Overview

The system of controlling radiation work is based on the issuance of written authorizations. This program is designed to keep personnel radiation exposures as low as reasonably achievable (ALARA) by providing administrative control of work activities involving radiation and by ensuring that adequate safety precautions are taken in areas with radiological hazards. Based on an analysis of the project's hazards, requirements such as dosimetry, bioassay, engineering controls, user and EH&S surveys, instrumentation, ALARA work procedures, and protective equipment shall be specified. The authorization shall limit work in the following ways: authorized personnel, authorized radioisotopes, inventory limits, authorized areas, and scope of work. Routine assessments shall be made by RPO to determine compliance with the requirements and to assess radiological conditions. Periodic reports will be sent to the work leader.

An authorization can be terminated by division management, RCM, or the RSC in response to repeated or serious violations of the requirements, or unsafe conditions.

Radiological Work Authorization (RWA). RWAs are issued for activities that are considered long-term projects under routine radiological conditions, such as an ongoing research project using radioisotope tracers. They are renewed at least every 18 months (within 60 days of 18 month anniversary).Use of very low activity radioactive material is covered by a Low Activity Source Authorization.

Radiological Work Permit (RWP). RWPs are issued for the performance of specific, non-routine radiation work, such as a decommissioning or maintenance project, and are normally valid only for the duration of the specific project.

Sealed Source Authorization (SSA). SSAs cover possession and use of accountable sealed radioactive sources. All authorized sealed sources are listed on the SSA. SSAs are renewed at least every 18 months (within 60 days of 18 month anniversary). For non-accountable sealed sources (exempt quantities), an Exempt Source Memorandum is issued.

Radiation Producing Facility Authorizations: The authorization basis for radiation- producing machines such as accelerators and x-ray units consists of a hazard analysis document such as an Activity Hazard Document (AHD), X-ray Authorization (XA), RWA, or a Safety Analysis Document (SAD). These documents specify safety features, shielding, and operating procedures, and describe potential hazards. Updates of these documents are required when radiological aspects of a facility or process are changed significantly or if radiological controls or safety requirements must be changed. XAs and RWAs are renewed at least every 18 months (within 60 days of 18 month anniversary).

Safety documentation must be reviewed and approved by the Environment, Health and Safety Division, including the RPO, and be kept current. A complex facility

such as an accelerator associated with multiple projects may have several authorization documents, such as an overall AHD or SAD and a number of RWAs.

7.2 Radiological Work Authorization Program

The RWA system controls the large majority of radioisotope work at LBNL. It is described in detail in the following section. The other controlling systems are operated in a similar way and are described only with respect to major differences from the RWA Program. Work with exempt-quantity material does not require a RWA. See the last part of this section for a description of the controls for exempt quantities.

7.2.1 RWA Application

It is the responsibility of the work leader to request an RWA when radioactive material is to be obtained for a project. The request must be sent to the RPO. The following information is requested:

- The department, building, and room number(s)
- The name and title of the applicant (work leader). The applicant must be the supervisor or the PI.
- The names and titles of all other personnel participating in the project. Training requirements must also be met prior to independent work with radioactive material (see Section 8).
- Isotopes and amounts to be used. For each isotope, the request must include the chemical and physical forms, the maximum activity to be used per experiment, per stock order container, total possession at any time, and the anticipated total annual use.
- Proposed uses. The procedure to be followed must be described in sufficient detail to permit a radiation safety evaluation to be made. Plans for handling and storing radioactive materials, care of radioactive animals, disposal of radioactive wastes, or any other applicable radiation safety issues should be included. Potential problems, such as possible mixed waste production and the possibility of facility contamination, should be noted.
- Protective equipment, e.g., fume hoods, glove boxes, safety equipment, shielding, etc.
- Survey instruments available..
- ALARA procedures: Description of methods used to reduce exposure.

7.2.2 Review and Processing of RWA Applications

After an application is completed, the RPO conducts a detailed review of the proposed project in order to determine the appropriate precautions, limitations, and ALARA practices necessary to ensure both good and safe work practices. This review must be followed by a personal interview with the applicant and an inspection and evaluation of the proposed workplace(s). A hazard classification is assigned based on isotopes, activity, and use. Classification ranges from I (lowest) to III (highest). Precautions and requirements with respect to shielding, containment, monitoring, and surveys (by RPO and laboratory staff), instrumentation, dosimetry, posting and labeling, and ALARA procedures are determined. Tables 7-1 through 7-4 depict the guidelines used to determine hazard classification and controls. The RWA is then prepared with all limitations and requirements documented. Approval is obtained from the responsible health physicist, the RCM, and the RSC as appropriate (see Appendix A). The RWA is then routed to obtain approval by the work leader, and the Division Director. After all approvals are complete, the RWA is activated. The RWA database is modified so that the laboratory may receive isotope shipments.

Changes in use, isotopes, or limits (significant change or hazard increase) require amendment to the RWA, which will generate a similar review and approval cycle.

7.2.3 Specific Items to be Evaluated

Table 7-1 lists specific items to be evaluated during RWA processing.

A Hazard Guide Value (HGV) is determined using the following formula:

$$HGV = QTU,$$

where Q = Quantity of radio nuclide in microcuries,
T = Relative toxicity factor (RTF; see Table 7-2), and
U = Use factor (see Table 7-3)

Table 7-1. Specific items to be evaluated during RWA processing

Factor	Details
A Radioisotopes	Evaluate each radioisotope, its activity, and its chemical and physical form. Prescribe usage limits appropriate for the facility's engineering safety features and the scope of work activity.
B. Personnel/ Training	All personnel listed on the RWA form must be qualified Radiological Workers. These users have completed EH&S radiological worker training and applicable on-the-job training documented by the PI. Unqualified workers must have completed GERT and be under the direct supervision of a qualified Radiological Worker.
C. Procedures	Evaluate procedures to be followed in using the requested materials to ensure radiological safety measures are adequate. Include • experimental protocol • specific methods for conducting the phase of the experiment using radioactive material.
D. Waste disposal	Evaluate the volume of waste expected and any waste minimization plans.
E. ALARA	Determine how the quantities and procedures are designed to keep worker and public radiation doses as low as reasonably achievable (ALARA).
F. Hazard Classification	Assign a hazard classification by making a quantitative determination of the hazard by taking into account isotope activities, toxicity, and dispersibility. The hazard classification will determine the control and surveillance levels
G. Radiation Contamination Control	Evaluate the following: • surveillance methods and frequency • radiation detection equipment • area postings, labeling, and access control • contamination control procedures • shielding requirements and possible radiation levels • protective clothing • possible levels of volatile or dispersible radioactivity (effluents and controls to be evaluated by EH&S Environmental Protection Group)
H. Dosimetry Requirements	Evaluate the dosimetry and bioassay requirements needed.
I. Facility	Evaluate the adequacy of the rooms, laboratories, and other workplaces for the proposed radiation use with respect to • storage facilities • hoods, glove boxes, and other special equipment • housing and maintenance of experimental animals, if used • effect of radiation on surrounding area • room diagrams and specific locations where radiation is to be used.
J. Reviewer Signatures	Personnel who are required to review this evaluation must sign the RWA document indicating that their review is complete.

Table 7-2. Relative Toxicity Factors

RTF[1]	Relative Toxicity	DAC (μCi/cm^3)
100 (^{239}Pu, ^{238}U)	very high	$< 10^{-9}$
10 (^{125}I, ^{90}Sr)	high	$10^{-7} – 10^{-9}$
1 (^{32}P, ^{14}C, ^{35}S)	moderate	$10^{-5} – 10^{-7}$
0.1 (^{3}H)	low	$> 10^{-5}$

[1]The RTF of DNA-seeking compounds is increased by a factor of 10 for ^{3}H, ^{14}C, and ^{125}I.

Table 7-3. Examples of Use Factors

Type of Operation	Use Factor U
Sealed sources	0.001
Storage of unsealed radioisotopes	0.01
Simple wet operations Examples: dilution, transfers, closed systems with appropriate traps used in hoods.	0.1
Normal chemical operations Examples: chromatography, filtration, centrifugation, animal injections	1.0
• Simple dry operations • Transfer and manipulation of dispersible material • Complex wet operations • Production and use of volatile material	10.0
Complex dry operations Examples: crushing, mixing, sieving	100.0

7.2.4 RWA Hazard Classification

The Hazard Guide Value methodology and RWA classification is adapted from guidance in the Health Physics and Radiological Health Handbook, 1992. This guidance is based on *Guidelines for the Radiation Protection of Workers in Industry*, International Labor Organization, 1989.

- Each RWA is classified according to hazard, as shown by the Hazard Guide Value.
- The following classifications are assigned.
  - Class I: HGV below 500
  - Class II: HGV between 500 and 50,000
  - Class III: HGV greater than 50,000
- These hazard classifications determine the operating rules for the workplace, as shown in Table 7-4.

7.2.5 Review and Renewal

RWAs are renewed at least every 18 months (within 60 days of 18 month anniversary). For ongoing projects, an evaluation of procedures and safety controls shall be made at the time of renewal. RPO surveys and reports must also be reviewed to determine compliance with the conditions of the RWA. Additionally, dose reports and any incidents, such as spills, shall be evaluated during the review.

If the evaluation is satisfactory, the RWA will be renewed.

If there are problems with compliance, or if it is determined that changes in the RWA are required, the user shall be notified of corrective actions necessary for renewal.

For RWA reviews, a project meeting is scheduled with an RPO Health Physicist to review any findings of noncompliance and review specific areas of concern. There is a review of requirements and changes, a review of workplace radiation hazards and mitigation, and a discussion of ALARA concepts specific to the workplace.

Table 7-4. Workplace Classifications

Class	Applies to	Operating Rules
I	Most low-level work with unsealed radioactive material	• Work surfaces for radioactive experiments must be smooth and impermeable. • Radioactive materials must be stored in refrigerators, freezers, or other suitable containment. • Gloves, lab coats, and safety glasses must be worn. • Absorbent paper must be used on work surfaces. • Appropriate waste disposal containers must be available. • Portable survey and monitoring equipment must be used, if appropriate.
II	Medium and moderately high-level radioisotope work	All Class I design features **plus the following** will be considered. • local shielding • remote handling equipment • fume hoods with an average air flow across the face of 100 lfm • special enclosures
III	Very high-level radioisotope work	All Class II design features **plus the following** will be considered. • high-efficiency filtration of exhaust ventilation • glove boxes with appropriate filters • remote manipulators • isolation from other work areas • clothing change area • hand and foot monitors, external radiation monitors with alarms, and continuous air monitors with alarms • sophisticated wash and storage facilities • access control

7.2.6 Termination of RWA

Completion of project: An RWA may be terminated at the request of a work leader when a project is finished. All radioactive materials are disposed or stored under another active RWA or RWP. A termination survey is performed, and the area is released for non-controlled use.

For cause: The RCM, division management, or the RSC, may suspend an individual's use of radioisotopes or an entire RWA if requirements are not met. This action must be immediately documented in writing by memorandum to the appropriate PI, the RWA Coordinator, and the RCM and RSC. The database should be modified as required so isotopes may not be received. Examples of reasons for termination or suspension are repeated unnecessary exposure of personnel, non-reporting of spills and suspected high exposures, and disregard for specified RWA precautions, limits, and requirements. The RWA may be reinstated after appropriate corrective actions are made and approvals are obtained as in initiating an RWA.

7.2.7 Records

Records in the laboratory include a copy of the RWA, use protocols, daily use logs, RPO surveys and other correspondence, self-survey records, and on-the-job training records.

RPO RWA files include RWA and support documentation, Experiment Observation Reviews and support documentation, RPO routine surveys and compliance checks. Other RWA related files maintained include Dosimetry Alert Level investigations, and incident investigations.

7.3 Low-Activity-Source (LAS) Authorization

For those projects possessing or using unsealed radioactive material at or below the limits of Appendix C of 10 CFR 20, RPO has the option to issue an LAS authorization rather than an RWA. Each laboratory (room) may have no more than one project using LAS quantities. Application for the LAS authorization is to be made by the responsible researcher over the phone or via e-mail, describing the following:

- materials to be used
- proposed use
- work/storage areas
- delivery point information
- names of users
- waste disposal
- survey needs

7.3 Low-Activity-Source (LAS) Authorization (continued)

General Employee Radiation Training (GERT) is required for all LAS users.

LAS Approval. The LAS authorization is formalized in a document that is sent to the applicant; the applicant retains a copy and returns a signed copy to RPO. The authorization is for a term of approximately 18 months; near the anniversary of the application, RPO will call to review the continuation of the LAS Authorization for another term. No other surveillance or administrative requirements of the RWA program apply. RPO shall spot check the workplace on a case-by-case basis.

7.4 Radiological Work Permit Program

RWPs are initiated in much the same way as RWAs. They are usually generated by RPO in conjunction with a maintenance or decommissioning activity that is directly controlled by RPO. The same information is necessary to complete an RWP (project description, radioactivity, radiological concerns, personnel, ALARA concerns, safety equipment). An analysis is performed; and the RWP is produced with appropriate requirements and approved by the work leader, and RCM, and RSC as appropriate. Radiological conditions are also specified in the RWP. The RWP is posted at the job site. RWPs are terminated at the end of the project. Records include radiation and compliance surveys, RWP, and support documentation.

7.5 Sealed Source Authorization Program

All accountable sealed sources used must be authorized by a SSA, RWP, or RWA. If unsealed sources are in use in a workplace, sealed sources shall be included in the unsealed source authorization, usually an RWA. Information regarding all sealed sources to be possessed must be obtained by RPO so a hazard evaluation may be made. Information needed includes a project description, activity of each sealed source, name of source custodian to whom the SSA shall be issued, and all users of the sources. Additionally, information about shielding, containment, and ALARA concerns may be necessary, based on the nature and use of the source. With this information, a hazard analysis is made similar to the RWA process, and a classification is assigned based on isotope, activity, and exposure rate. Precautions and restrictions are specified, such as dosimetry, shielding, posting, labeling, and ALARA procedures (such as remote handling). The SSA is then approved by the custodian, Division Director, RCM, and RSC, as appropriate.

Renewal takes place at least every 18 months (within 60 days of 18 month anniversary) in the same way as with RWAs. Surveys, compliance, procedures, and safety controls are assessed. An SSA renewal project meeting is scheduled by the RPO to review any findings of noncompliance and review specific areas of concern. There is a review of requirements and changes, a review of workplace radiation hazards and mitigation, and a discussion of ALARA concepts specific to the workplace. Records include SSAs, source inventory, and leak tests.

Sealed Source Authorization Program (continued)

The following italicized section is included to document the full program. It is not a part of the 10 CFR 835 RPP.

Note: Sources known to be generally licensed by NRC or Agreement States shall be tracked and disposed of properly. They shall be leak-tested according to manufacturer's requirements.

7.5.1 General Requirements for accountable sources

- When not in use, sealed radioactive sources are stored in a locked cabinet or storage room posted as a Radioactive Material Area.
- A sealed source log that lists the location and current user of each source must be maintained by the custodian.
- SSAs must be modified before additional sealed sources may be obtained.
- Transfers of sources between custodians must be approved by RPO.
- Sources coming or going from/to off site must be transferred by RPO, unless specific authorization has been given.
- Source or storage location must be labeled with radiation symbol, "Caution—Radioactive Material," isotope and activity, and date of assay.
- Surveillance required is semiannual leak-testing and inventory . Leak tests are also required prior to transfer. Inventory and leak testing is not required if the source is inaccessible.
- Sealed sources not authorized for use and in storage need not be leak tested until released from storage.
- Sealed source users must have radiological worker training.

7.5.2 Non-accountable sources

Sealed sources that are below accountable levels and have been identified shall be documented and inventoried approximately annually. Proper labeling shall be required.

7.5.3 Source Integrity (Leak) Tests:

(1) Except as specified below, accountable sealed sources are inspected for source integrity and tested for leakage by RPO semiannually or whenever damage is suspected to have occurred. Leak check results are documented by RPO on the sealed source database; hard copies of test results are also maintained.

(a) Sources in storage need to be leak tested only when they are removed from storage and before being placed in use.

(b) A leak test is not required for sources containing only gaseous isotopes or tritium.

(2) A leak test result that reveals the presence of 0.005 microcuries or more of removable radioactive material is an indication that the source has lost its integrity, and the source should be removed from service and must be managed as an unsealed source.

(3) Instrumentation used for analysis of leak test samples shall be capable of detecting 0.005 microcuries of any isotope tested.

7.6 Radiation-Producing Machines

All accelerators, x-ray machines, and irradiators are covered by approved safety documentation that specifies design, controls, posting, entry control, and operating safety procedures. Requirements, such as posting and entry control, are evaluated (see Sections 10 and 11) and are placed in the controlling authorization. Posting is verified and adjusted as necessary by RPO during routine surveys. Line management is responsible for adhering to the authorization requirements. RPO surveys the devices at startup and both RPO and users survey routinely.

7.6.1 Accelerators

The EH&S accelerator radiological control program consists of the following functions:

- Consulting with operations personnel, experimenters, and monitoring personnel
- Designing and reviewing shielding and other safety systems and reviewing Activity Hazard Documents (AHDs) or Safety Analysis Documents (SADs). SADs are prepared for major facilities.
- Training operations and monitoring personnel
- Monitoring area radiation
- Dosimetry
- Posting and entry control

Experimenters and operations personnel must consult with RPO before planning new facilities or operations. Operations must be designed and conducted in such a way that personnel cannot be overexposed during "worst case" conditions and normal operational exposures are below administrative levels. See Design Review in ALARA section. For major facilities, projected occupational dose must be as far below 20 percent of limits as is reasonably achievable.

7.6.1 Accelerators (continued)

Before initial operation is begun at any LBNL accelerator or ion source, a radiation survey must be carried out by the RPO. Surveys may also be carried out whenever radiological conditions might change. Interlocks and warning devices must be checked and systems serviced (and the task documented) by the operating groups at intervals not to exceed six months. LBNL PUB-3000 specifies requirements for interlocks.

All accelerator operators must be assigned appropriate dosimeters and have radiological worker training. Radiation training and dosimetry requirements for others working in or around accelerators shall be determined by the Radiological Work Authorization and/or potential exposure.

(1) RWAs, RWPs

Any work in an accelerator with radioactive material, such as target handling, is generally covered by a RWP or RWA whereby hazards are evaluated and special requirement are put in place. One exception is the handling of low-level induced shielding material.

(2) Induced Activity

Materials removed from areas where activation is possible must be characterized as to activity and radiation levels. Items may not be removed from the accelerator Controlled Areas for unrestricted release until a release radiation survey has been performed by RPO.

(3) Occupancy of Beam Enclosures

LBNL policy requires radiation safety interlock systems at particle accelerators to protect personnel from accidental exposure to hazardous levels of radiation. Interlocks must be addressed in the Authorization Document.

Occupancy of a beam enclosure while the beam is directed to that area is not normally allowed unless specifically permitted in the facility authorization document.

Entrances to such enclosures must be interlocked to the beam permissive-logic control system for safety. Overriding these safety mechanisms for purposes of convenience or expedience is not permitted.

7.6.1 Accelerators (continued)

If occupancy is required, a variance to this policy must be requested from the facility manager and RPO.

It must be shown why other methods cannot be used to avoid the need for a person to be in the enclosure with the beam on.

Alternate means to ensure equivalent degrees of safety and adequate provisions for monitoring radiation levels and personnel exposures must be shown. Self-reading dosimeters are usually required.

Provisions to ensure that the beam shall not deviate so as to increase radiation levels in the enclosure must be in place (example: dose-rate activated interlock). A study must be made of possible fault conditions that might lead to higher-than-anticipated radiation fields in the enclosure or in other occupied areas.

Full details of work to be done and precautionary measures to be taken during this mode of operation must be included.

A Special Authorization must be approved. The accelerator operators must be informed of the provisions of the Special Authorization and understand their authority and responsibility during the variant operation.

Any work in a Radiation Area or handling of radioactive material, whether the beam is operating or not, shall require a Radiological Work Permit or a Radiological Work Authorization.

7.6.2 X-Ray-Machines

The following sentence is included to document the full program. It is not a part of the 10 CFR 835 RPP.

LBNL has adopted guidance from ANSI N43.2, Sections 5.2.1.1, 5.2.1.2, 5.2.2.3, 5.2.2.1.4, 6.5, and 7.1.

All x-ray machines must be covered by an X-ray Authorization (XA). This document must be prepared and approved prior to operation. This XA must contain at least the following:

- The name of the person responsible for the unit (system supervisor)
- A list of authorized users
- A list of authorized instructors
- A list of authorized maintenance personnel
- An emergency or problem call list
- Equipment descriptions and parameters• Descriptions of safety features and procedures

This document is be renewed at least every 18 months (within 60 days of 18 month anniversary). At that time a complete review of safety and compliance is made.

(1) Safety Features

- All systems must have an interlocked enclosure that prevents access to the x-ray beam under normal operation.
- There must be a fail-safe light or indicator that gives a positive indication that high voltage is applied to the x-ray tube.
- There must be a key-controlled switch that controls the main power to the x-ray generator.
- If the device can be operated with the enclosure open, there must be fail-safe shutter lights or devices that indicate that the shutter is open, and the shutter must be interlocked with the accessory apparatus
- A use log and maintenance log must be maintained.

(2) Radiation Safety Surveys and Monitoring

All x-ray-machines must have a radiation safety survey performed by the X-ray Safety Officer or designee at least once a year for machines in active use and upon startup of machines that have been removed from service. Additionally, each analytical x-ray machine must have an area monitoring device that alarms when radiation level exceeds a defined set point, usually less than 1 millirem per hour.

In addition, all x-ray machines must have a radiation safety survey performed:

- Upon installation but before regular use
- After a repair operation that could have caused a change in the condition of shielding or safety protection devices
- After any repairs or maintenance that could affect the performance of a medical diagnostic machine
- Upon request by the users or RPO

The safety survey must be recorded in the User's Log. To supplement these major surveys, the X-ray System Supervisor for analytical equipment must spot-check the x-ray machine for radiation leakage (at least annually) and interlock function (at least semiannually, unless otherwise prescribed in the SSA).

(3) Training

For x-ray machine users, a distinction is made between "routine users" who can only operate the machine with interlocks in place (no access to the x-ray beam) and "x-ray system operators" who supervise x-ray machine personnel, maintain machines, instruct users, or have access to override interlocks. Routine users are subject to training by a designated x-ray system operator. X-ray system operators are considered radiation workers and must be trained as such by RPO per radiation worker training requirements in Section 9. The training program for the routine users was developed by RPO and contains all elements of 10CFR835.901.c, including a test. Documentation of routine user training is audited routinely by RPO.

7.6.3 Irradiators

The following two sentences are included to document the full program. It is not a part of the 10 CFR 835 RPP.

Use of irradiators is controlled by requirements similar to those of x-ray devices. LBNL has adopted ANSI N43.3 Sections 4.1, 5.1.1, 5.1.2, 5.1.4, 5.1.5.2, 5.1.5.7, 5.1.6.3, 9.1, 9.2, 9.4, and Annex 3.

The authorization documents for irradiators are the AHD (or XA in the case of a machine irradiator) or an SSA or RWA(in the case of a sealed source irradiator). These documents must contain users, instructors, emergency call list, safety features, and operating and safety procedures. They must be approved by the RCM. Fail-safe indicators and interlocks are required. A use and maintenance log is required to be maintained. Whole body dosimetry is required, and self-reading dosimetry is required of personnel entering the irradiation chamber. A fixed radiation monitor connected to the interlock system is required in the irradiation chamber. An annual radiation survey (or after modification) by RPO is required, and a system safety check must be performed by the user every six months.

Training: See training discussion in the previous section. Routine users of these devices who do not supervise, instruct or maintain the units are trained by the system supervisor as described earlier.

The following section is included to document the full program. It is not a part of the 10 CFR 835 RPP.

7.6.4 Radiography

LBNL has adopted CCR (California) Title 17 Sections 30330–30337. All radiography performed on site must comply with these standards. Commercial radiographers doing work on site shall be audited for compliance with these requirements.

8. RADIATION PROTECTION TRAINING

8.1 General

Individuals shall receive radiation safety training on the following topics, commensurate with the hazards in the area and the required controls before being allowed unescorted access to controlled areas and before receiving occupational dose during access to Controlled Areas:

- Risks of exposure to radiation and radioactive materials, including prenatal radiation exposure
- Basic radiological fundamentals and radiation protection concepts
- Physical design features, administrative controls, limits, policies, procedures, alarms, and other measures implemented at LBNL to manage doses and maintain doses ALARA, including both routine and emergency actions
- Individual rights and responsibilities as related to implementation of the facility radiation protection program
- Individual responsibilities for implementing ALARA measures required by 10CFR835.101
- Individual exposure reports that may be requested in accordance with 10CFR835.801

If an escort is used in lieu of individual training, the escort must have completed the requisite training for area entry and/or work performance and must ensure that escorted individuals comply with radiation protection program requirements.

Training shall be conducted at intervals not exceeding 24 months or when there are significant changes to radiation safety procedures or practices that may affect the individual.

8.2 Non-Radiological Worker Training

The most basic level of training at LBNL consists of information appropriate for non-radiological worker access to controlled areas. This training is known as General Employee Radiation Training (GERT). It consists of written materials with general and site-specific information pertinent to the LBNL site. This information is distributed to all individuals when they receive their site access badges. Typically this is within several days of their start date. By targeting all new staff, LBNL ensures that the relatively modest fraction that actually enters Controlled Areas shall receive the appropriate training. The information may also be given via a classroom course, video, electronically, or by a briefing prior to entry to the Controlled Area. All forms of GERT incorporate all of the topics in Section 8.1.

In concert with the identification of training requirements, each Controlled Area has signage that states that radiation safety training is required. Additionally, some of the higher risk facilities have engineered access controls that insure that applicable training requirements are met before individuals are allowed unescorted access.

GERT retraining is provided by a site-wide distribution, electronic and/or hard copy, of GERT retraining materials. This is done on a biennial basis.

8.3 Radiological Worker Training

All employees must complete radiological worker training before being permitted unescorted access to Radiological Areas and before performing unescorted assignments as a radiological worker. The training shall include the topics listed above, commensurate with the hazards and required controls and an examination and performance demonstration. The training required depends on the nature of the radiation work. Most individuals must attend courses given by the RPO, and then are provided on-the-job training by the laboratory supervisor or designated person. With sufficient previous training and experience, the individual may be given credit for the generic portion of the training or may be allowed to take a challenge exam in lieu of the formal training. At least two years experience working with similar sources of radiation is required to qualify for the challenge examination. For credit by previous training, the previous training must be documented and received within the past two years. The training documentation is evaluated by RPO and must be equivalent to that portion of the LBNL radiological worker training. This radiological worker training is modular. Workers who meet the criteria for this training requirement must complete a fundamentals course that includes radiation physics, ALARA principles, biological effects, LBNL procedures for radiation control, authorizations, regulations, and emergency procedures. In addition, job-specific training is given for the type of radiation source that the worker will be using (accelerator, unsealed radioactive

8.3 Radiological Worker Training (cont.)

materials, x-ray machine, sealed sources, or maintenance project). The

fundamentals course materials may be incorporated into the job-specific training in some cases, or the modules may be given as separate classes.

Each course has an examination requirement. Performance demonstration will be conducted either during the classroom training or as part of the on-the–job training (see next paragraph).

Another component of this training is on-the-job training from supervisors or other designated radiological workers on the specific radiation-related operations the workers will be required to perform. Special attention is to be applied to radiation safety control measures and procedures.

Retraining is required whenever there are major changes in policy or procedures, or at intervals not exceeding 24 months, whichever comes first. Retraining may be accomplished in the workplace during an authorization renewal meeting or other radiation safety meeting with an RPO health physicist. Refresher information on the general topics in Section 8.1 shall be given, along with information specific to the workplace (surveillance results, program compliance with LBNL requirements, review of requirements and changes, review of workplace radiation hazards and mitigation, ALARA concepts specific to the workplace). This review and facility visit and discussion shall be documented. If it is not feasible for a worker to attend this type of meeting, the retraining requirement may be fulfilled in the same manner as the initial training. This retraining requires an examination and performance demonstration.

8.4 Radiation Protection Program Personnel Training

Individuals responsible for developing and implementing measures necessary for ensuring compliance with the requirements of 10CFR835 shall have the appropriate education, training, and skills to discharge these responsibilities. Radiological control personnel should possess the knowledge, skills, and abilities commensurate with their position and the responsibilities of that position.

At LBNL, education and experience requirements are in place for the various job classifications, documented in the LBNL Regulations and Procedures Manual. Some flexibility is allowed within the requirements as determined by the RCM. The RCM supervises all RPO personnel and is responsible for determining the classifications of the staff positions. All position classifications, including calibration, analytic laboratory, dosimetry, and administrative staff are evaluated by the RCM for adequacy of training and experience requirements. Once an individual is employed, a Training Plan is documented, based on the position classification and a job hazards evaluation. As part of the LBNL Division self assessment program, the RCM periodically assesses completion of required training of RPO staff. For Health Physicists and RCTs core training requirements, and additional position specific and procedural training requirements are identified on the Training Plan. Completion of all the requirements and sign off of the Training Plan by the supervisor and RCM are required for full qualification.

Radiological Control Technicians (RCTs) are those individuals within RPO whose primary job assignment involves field-level implementation of the Radiation Protection Program, i. e. monitoring of workplace radiological conditions, specification of protective measures, and provision of assistance and guidance to other individuals in implementation of radiological controls. RCT training includes both classroom and practical training. The level of knowledge of radiation safety must be verified by examination, including demonstration, prior to any unsupervised work assignment. Prior to full qualification, an RCT must work in the presence of a qualified RCT. Initial training shall consist of basic-concepts core training verified by examination. This shall be followed by performance-measure training for the tasks assigned. Successful demonstration of skills and knowledge for each performance measure is required for qualification. With sufficient previous documented training and experience (training within the past two years), or current NRRPT (National Registry of Radiation Protection Technologists) certification, the individual may be given credit for the generic portion of the training. The RCM will make the evaluation. Retraining is required at least every 24 months and shall be given via repeat training or challenge examination and reassessment of practical skills.

Other personnel at LBNL responsible for implementing the RPP are line managers of divisions where work with radioactive materials or radiation producing machines is performed, division safety personnel, and institutional safety committees. Authorizations for radiation work at LBNL identify the person directly responsible for the project (RWA Principal Investigator, X-ray System Supervisor, Sealed Source Custodian, etc). These individuals must have full qualification as radiological workers, plus additional training regarding their responsibilities.

The LBNL Integrated Safety Management System, described in Section 3 documents how all divisions of LBNL incorporate safety into their programs. Each division has an EH&S Plan that documents accountability for safety. Divisions have Safety Committees and Safety Coordinators that assist in the implementation of safety requirements and work to increase safety awareness of division personnel at all levels. All line managers are required to determine the requisite skills, knowledge, and training of their staff to function safely. As described above, Division Self Assessments verify that required training and qualifications have been obtained.

9. RADIOACTIVE MATERIAL TRANSPORTATION AND PROCUREMENT

The following sections (in italics) are included to document the full program. They are not a part of the 10 CFR 835 RPP.

49 CFR 170 through 180 describe requirements for inspecting and surveying packages, containers, and transport conveyances prior to transport off the contiguous LBNL/UC property. The 49 CFR 173 contamination values shall be used as controlling limits for offsite shipments transported by common carriers. 49 CFR 397 describes routing of radioactive material shipments. International Air Transport Association (IATA) Dangerous Goods Regulations also prescribe packaging and certificate requirements. LBNL has adopted these standards.

9.1 Procurement and Receipt of Radioactive Material

Radioactive material may only be purchased via an approved RWA, RWP, or SSA, or other authorization/approval method through RPO. Personnel purchasing radioactive material are requested to have the authorization number placed on shipping papers, and to indicate that materials are to be routed through the RPO Transportation Office. RPO Transportation picks up packages from LBNL Transportation on a daily basis, soon after carrier delivery. Packages are surveyed as soon as practicable, and within 8 hours of receipt.

When packages are received, the following is done by RPO:

1. Check packing slips and identify the recipient.
2. Check for damage. Survey and process immediately if damaged (see below).
3. Verify that the recipient is authorized to receive the package (valid RWA, within limits, etc.).
4. Survey the package:
   - Verify Transport Index, if applicable.
   - Wipe test and meter survey all packages
   - Hold all contaminated packages. (Decontaminate, open package, and check for spillage.)
   - Notify carrier if above DOT limits.
5. Open all Type A packages (white or yellow labels). Check for contamination of inner containment and packaging. Hold if above limits in Table 4.3. (Repackage, decontaminate, dispose if necessary, notify recipient.)
6. Document all surveys. Enter package information (isotope, activity, chemical form, authorization) into RPO inventory database.

9.1 Procurement and Receipt of Radioactive Material (cont.)

7. *If the material is NMMSS accountable, the nuclear materials representative shall prepare and submit the proper forms.*

8. Deliver to recipient and obtain receipt signature.

9.2 Outgoing Shipments

All outgoing shipments must be controlled by RPO. Personnel wishing to ship radioactive material must generally prepare a request form with all pertinent information (isotope, activity, recipient, etc.).

When packages are received for outgoing shipment, the following is done by RPO:

1. Verify that the recipient is authorized to receive the material (DOE site or external licensee).

2. The material must be packaged and labeled per DOT requirements.

3. Survey the package and determine transport index, if appropriate. Verify that the interior and exterior are free of contamination and meet DOT requirements.

4. Document surveys and enter all data into the Outgoing Shipping Log.

3. Prepare DOT/IATA shipping papers as appropriate.

4. If the material is NMMSS accountable, the nuclear materials representative shall prepare and submit the proper forms.

5. Notify the carrier of the approved route, if appropriate.

6. If LBNL is the shipper, exclusive use, or waste shipment, perform an inspection and survey of the shipping vehicle per DOT requirements.

9.3 Transfers

1. *DOT rules shall be followed, for offsite transfers by any carrier.*
2. *RPO must be notified of transfers, unless previously approved (by RPO). The recipient must be authorized to possess the material.*
3. *For onsite transfers over LBNL roads (covered by LBNL procedures:*
   - *a. The radioactive material must be properly labeled (Section 10) and transported in releasable (Section 4.3) secondary containment. A sealed plastic or metal container or sealed plastic bag with absorbent material (capable of absorbing all liquid) is preferred.*
   - *b. A trefoil label with "CAUTION Radioactive Material" shall be attached to the primary container; labeling the secondary container is required if the label on the primary vial/container is not clearly visible through the secondary containment.*
   - *c. The material must be transported using a government vehicle.*
   - *e. Deviations from this procedure must be approved by RPO.*
   - *f. Transporters must be aware of emergency procedures for transport.*

10. POSTING AND LABELING

Posting and Labeling is performed in accordance with applicable regulations. Unless otherwise specified the posting and labeling shall have the radiation trefoil in black or magenta on a yellow background.

10.1 Posting

Except as provided by Section 10.3, Radiological Areas (Radiation Areas, High Radiation Areas, Airborne Radioactivity Areas, Contamination and High Contamination Areas) are posted with DOE-Approved signs at the entry to the area. Note that Airborne Radioactivity Areas are defined in Section 4.4.

Radioactive Material Areas are posted as follows (except as provided by Section 10.3):

- At entrance to (at bench if not an entire room) an area where unsealed radioactive materials are in use. Floor tape in conjunction with the posting is used to clearly delineate partial room RMAs.
- On storage containers, such as refrigerators or safes or rooms housing stored radioactive materials.

Radioactive Material Area posting shall include the words "Caution, Radioactive Material"

Areas which contain within them radiation levels or materials which must be posted as described above shall be posted as Controlled Areas.

10.2 Labeling

Except as provided by Section 10.3, radioactive items or containers shall have a durable label with the radioactive trefoil and the words "Caution Radioactive Material" and enough information to permit individuals who work with the material or nearby to control exposures. X-ray generating devices shall be labeled with a sticker indicating that the equipment can produce radiation.

10.3 Exceptions to Posting and Labeling Requirements

Exceptions allowed in 10 CFR 835.604 and .606 shall be implemented.

11. ENTRY CONTROL

An appropriate entry-control program must be established for any Radiological Area. The level of control must be consistent with the degree of hazard. Signs and barricades, control devices (e.g., locks) on entrances, conspicuous visual or audible alarms, and administrative procedures must be used as appropriate to control personnel entry. Authorization for entry shall be documented in a procedure or in the authorization for the radiation work, and shall specify appropriate radiation protection measures. No control shall be installed that prevents rapid evacuation of personnel under emergency conditions.

For High Radiation Areas, the entry-control program must include at least one of the following:

- Control devices on each entrance or access point that automatically prevent entry when the radiation level is above 1 rem (0.01 Sv) per hour or prevent operation of the radiation source or field while an individual is in the area.

- A control device that energizes a conspicuous visible and/or audible alarm that warns anyone entering the area of the radiation level and informs radiation protection personnel of the entry.

- Locked entryways, except during periods when access to the area is required, with positive control over entry and with radiation surveys made for the initial entry and periodically as necessary.

- Control devices that automatically generate conspicuous audible and/or visible alarms before operation of the radiation source to permit evacuation of the area or that prevent operation of the source when anyone is in the area.

For all High Radiation Areas, radiation exposure rates must be monitored upon entry and supplementary dosimeters must be used to immediately assess dose to individuals. The AHD, RWA, or RWP shall specify which controls are necessary in each case.

No access is permitted to Very High Radiation Areas, which are controlled by interlocks.

Respiratory Protection: The requirement for respiratory protection is delineated by the authorization (RWA or RWP) covering the workplace that must be entered. Procedures for various functions, such as certain radioactive material waste processing operations also call for respiratory protection. In general, respiratory protection at LBNL is used as a precaution in the event of an accidental release, rather than protection against known airborne contamination levels. There are no work locations at LBNL where airborne radioactivity in accessible areas warrants the routine use of respiratory protective devices. If respiratory protection is required, personnel assessment and fit testing are provided through a documented program in compliance with 29 CFR 1910.134, administered by the LBNL Industrial Hygiene Program.

12. RECORDS

Records shall be maintained sufficient to document compliance with 10 CFR 835 and this RPP. They will be maintained until final disposition is authorized by DOE. All record requirements, in Subpart H of the regulation shall be followed.

The following records are retained by or accessible by RPO:

- Approved authorizations
- RPO procedures
- ALARA goals, design reviews, and ALARA work reviews
- Training records of general employees, radiological workers, and Radiological Control Technicians, which include course content, courses required/ completed, examination results, credit-for-training documentation, RPO Staff qualifications, distribution of materials for general employee retraining.
- Reports of compliance audits (internal and external)
- Individual dosimetry and bioassay records. Dose reports described in Section 5.1.1 are also retained. All doses determined by external dosimetry or bioassay, or assigned as a result of an investigation that are above the reporting levels (Section 5.1), shall be recorded. Records of previous occupational dose for the year will be obtained or estimated in writing by the worker. Reasonable efforts will be made to determine prior years dose records for those individuals requiring monitoring. All dose records will be transferred to DOE when all site activities that could cause exposure cease.
- Records of area monitoring and special monitoring to assess dose
- Procedures and changes
- Records of area monitoring and special monitoring to assess dose
- Sealed source control, inventory and leak test records
- Radioactive material receipt, transfer, and shipping records.
- Instrument calibration records.
- Self-assessment records.

In addition, certain records, such as user surveys, on-the-job training, and authorization documentation must be maintained by authorized users at the work location. Radiological units used in records shall be in terms of multiples of curie, rad or rem. DPM (disintegrations per minute) may also be used for contamination control records. SI units may be added parenthetically.

13. EMERGENCIES

Instructions are given to radiological workers for various types of emergencies. They are summarized below. The LBNL Fire Department (7911) is the first responder in emergencies. They are trained to stabilize the situation and deal with injuries. They will notify RPO to facilitate their response. Minor spills can be reported directly to the EH&S Division or RPO. A general phone number with routing has been set up for this purpose.

13.1 Emergency Instructions

Emergency instructions and reporting phone numbers for radiological incidents are posted in each radiation use location.

13.2 Investigation

All incidents involving radiation shall be investigated by RPO, and a report covering causes, prevention, actions taken, results of cleanup and testing, lessons learned, etc., shall be prepared. More serious occurrences shall have a report prepared by an investigation committee. The committee shall consist of line management, possibly a representative of the Radiation Safety Committee, and a qualified representative of RPO. The RSC may elect to perform an independent investigation.

13.3 Overexposures

Employee emergency exposures are handled per regulatory requirements in 10CFR835.1301 and 1302 (recording, reporting, operations cessation, counseling). Only operations associated with the overexposure shall be stopped. Emergency exposure situations shall be likewise handled (risk assessment, volunteers, briefing, reporting, record keeping, and authorization for return to work)

The following section is included to document the full program. It is not a part of the 10 CFR 835 RPP.

14. HUMAN AND ANIMAL USE

LBNL has adopted the following standards:

- *21 CFR 361, Protection of Human Subjects, Informed Consent, Standards for Clinical Review Boards for Clinical Investigations, Medical Device Requirements, Human Subjects Committee Requirements.*
- *45 CFR 46 and 10 CFR 745, Common Rules for Protection of Human Subjects.*
- *CCR17 (California) Subchapters 4.5 and 4.6, Training Requirements for Technologists Administering Radiation to Human Subjects*

LBNL has committees that review and control the use of animal and human subjects. The LBNL Human Subjects Committee must approve all uses of human subjects in research. Pre-approval is also required by the UC Berkeley Committee for Protection of Human Subjects, an institutional review board, authorized by The Department Health and Human Services.

In compliance with 21 CFR 361.1, LBNL maintains a Radioactive Drug Research Committee. This committee reviews all radioactive drug administration to humans on site.

The LBNL Animal Welfare Research Committee reviews and approves all animal research on site in accordance with 7.U.S.C, the Animal Welfare Act.

Protocols and safety requirements for use of radiation with animal or human subjects are in the authorizations for the work. All personnel handling animals or humans who have received radioactive material are designated as radiological workers.

Nuclear medicine radiation protection standards are implemented via the Radiological Work Authorization Process. Items included shall *be required training for technologists administering radioisotopes to humans, and quality assurance of dose calibrators and imaging cameras.*

The following section is included to document the full program. It is not a part of the 10 CFR 835 RPP.

15. WASTE DISPOSAL

The Hazardous Waste Handling Facility (HWHF) is operated by the Waste Management Group of the Environment, Health and Safety Division. Radiological controls are implemented by means of an RWA issued to the facility by the RPO, and the assignment of an RPO health physicist for radiological oversight. Radioactive waste is collected in user laboratories and transported to the HWHF. There it is processed and/or packed for shipment to a DOE or externally licensed treatment or disposal facility. Brokers are not currently used. RPO coordinates outgoing shipments, which follow requirements outlined in Section 9.

Extensive programs are in place for waste generator training, characterization of waste streams, and quality assurance waste sampling, all designed to assure that stored and outgoing waste is properly characterized and meets disposal site acceptance criteria.

Waste processing activities and nominal radioisotope limits are described in general in Section 2.2. Procedures include:

- *collection and transport of radioactive and mixed wastes*
- *storage of these wastes*
- *compaction of dry radioactive waste*
- *sampling and packaging of radioactive and mixed wastes*
- *bulking (consolidation) of radioactive and mixed waste*
- *decontamination of equipment and areas*
- *packaging of scintillation vials*
- *neutralization of corrosive mixed waste*
- *solidification of liquid waste*
- *sewer disposal of aqueous waste*
- *inspection of all waste types*
- *maintenance*
- *HEPA filter change out*

The HWHF is a secure facility equipped with fume hoods, glove boxes, and drum hoods. Ventilation systems for the compactor and other enclosures are HEPA-filtered and continuously sampled.

Alternate means of disposal include decay and release (described in Section 5.4.1) and sewer disposal (described in Section 5.4.2). The radiation protection precautions and limits for routine process are described in detail in the appropriate EH&S procedure. Certain one-time procedures or special projects shall *be covered by either an RWP or a written protocol. In the case of an RWP, additional trained personnel may be used. Overall inventory and operations are bounded by the HWHF Safety Analysis Document.*

Waste Disposal (continued)

All HWHF procedures regarding Radiation Protection must be reviewed and approved by the assigned RPO health physicist.